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# ADAPTIVE OPTICS FOR LASER COMMUNICATION

Current activities and Outlook at Fraunhofer IOF

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Fraunhofer Institute for Applied Optics and Precision Engineering

Aoife Brady

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# Fraunhofer IOF

## Key facts

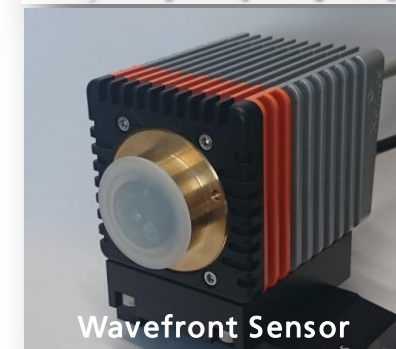
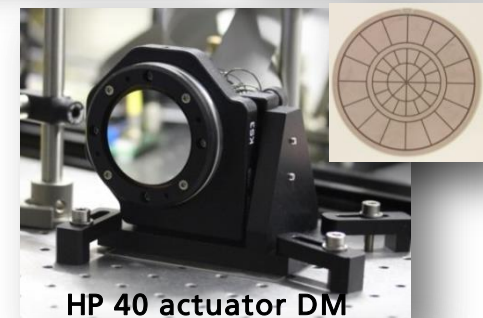
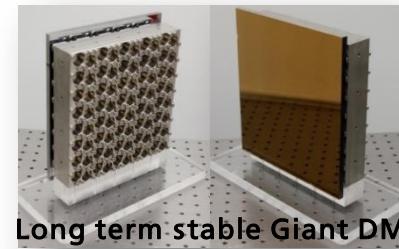
- Founded in 1992
- 200 Employees  
+ 72 Students



# Fraunhofer IOF

## Key facts

- Founded in 1992
- 200 Employees  
+ 72 Students
- Active and Adaptive Optics Group
  - Design and Manufacturing of various deformable mirrors (DMs)
  - 40 actuator high power DM: up to 6kW CW
  - AO system design
  - Design and Implementation of a portable AO box for laser communication

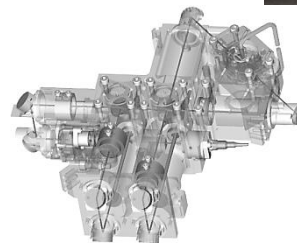
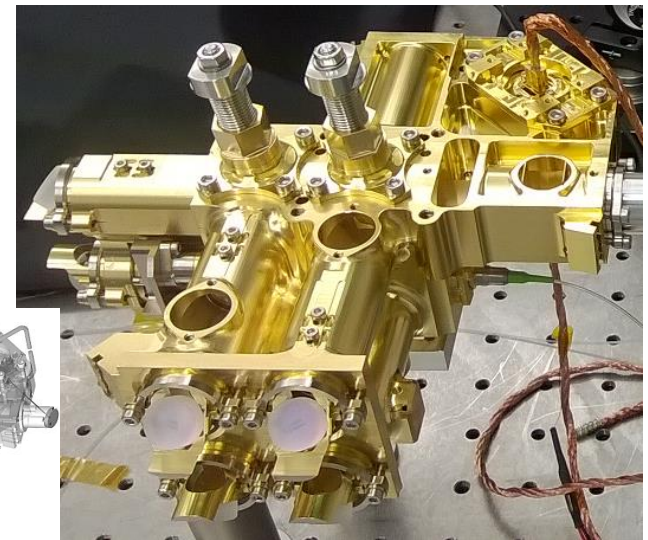
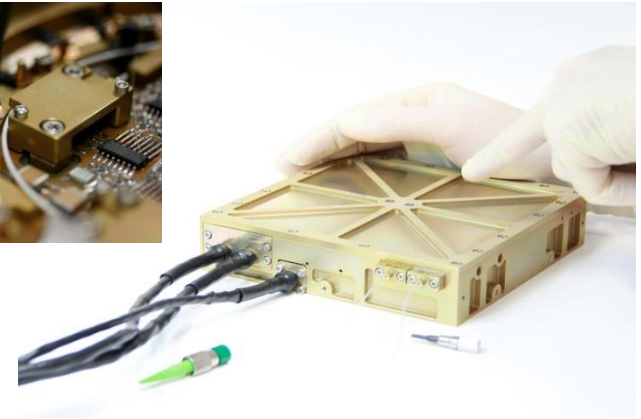
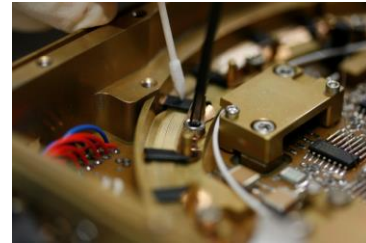


# Fraunhofer IOF

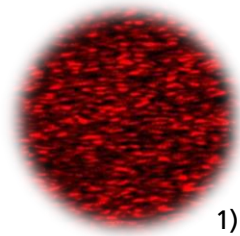
- Fiber laser group:
  - 2014 LIRIS experiment
    - Mounted on ATV5 to ISS
    - Fiber laser suitable for space applications



- Micro assembly group:
  - Entangled Photon Source (EPS)
    - Next Goal: TRL 6 (spring 2017)



# Motivation: Laser communication with GEO satellite

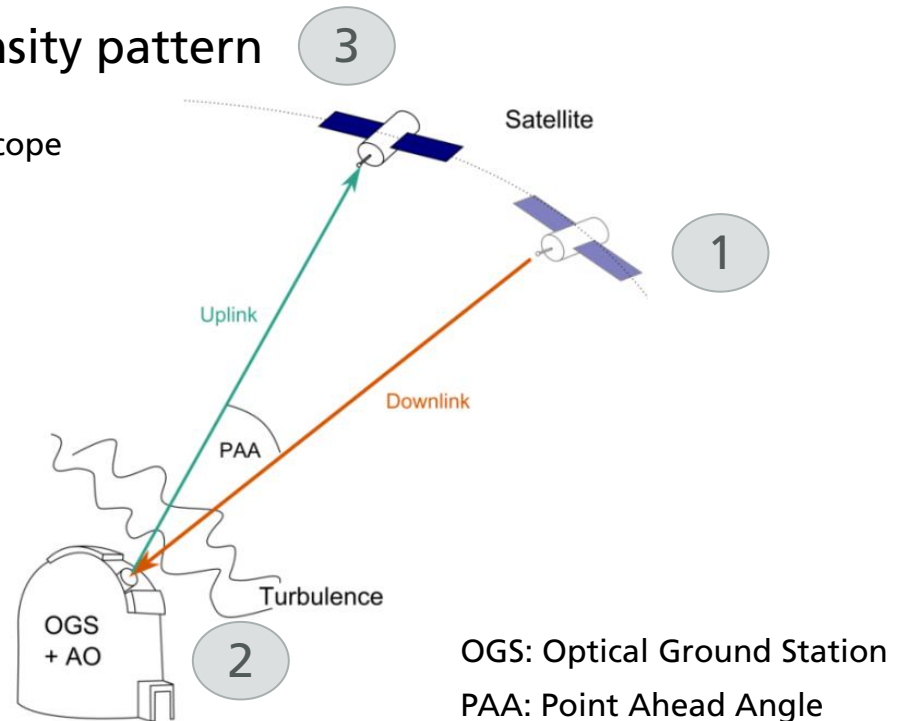


Speckle intensity pattern

$$\varnothing_{\text{speckle}} > \varnothing_{\text{Telescope}}$$

SOA: apply n-beams to homogenize intensity @ 3

SOA: Post-compensate downlink

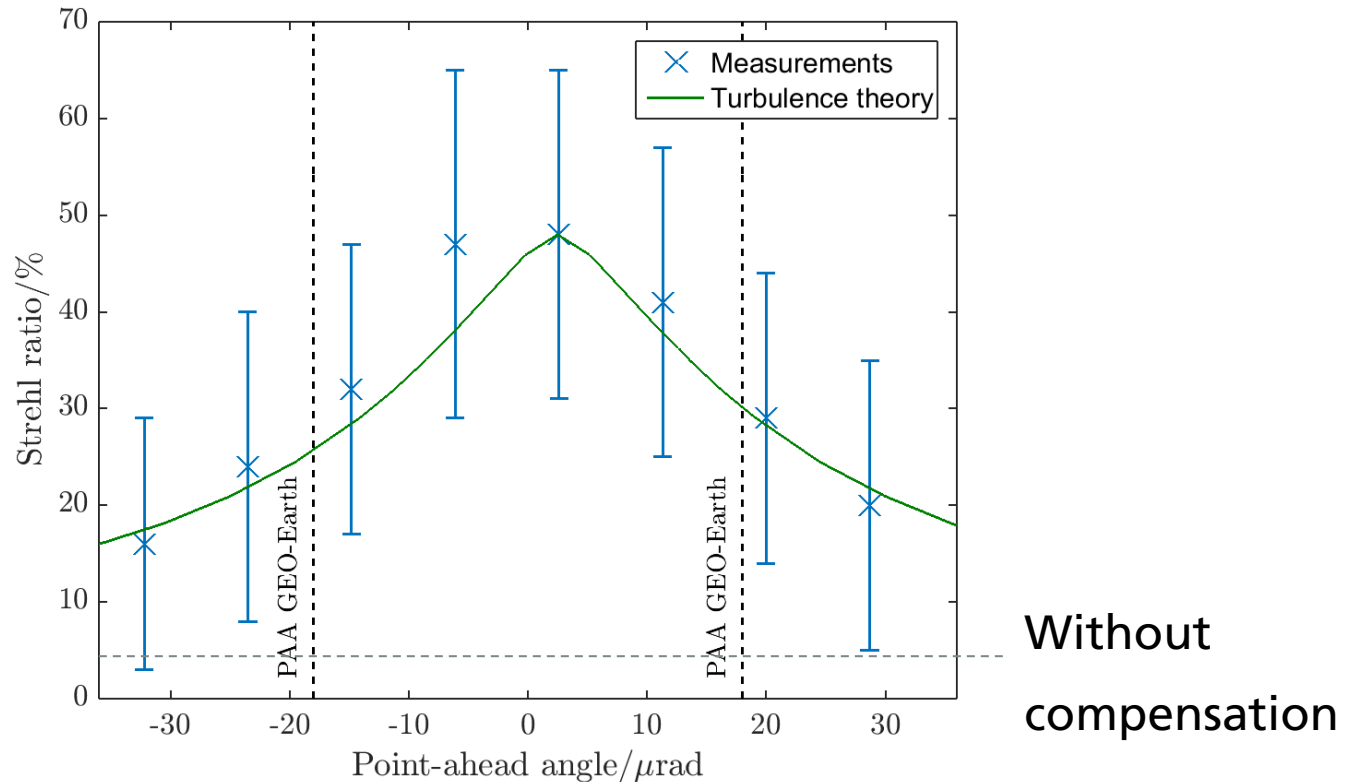


OGS: Optical Ground Station  
PAA: Point Ahead Angle

AO-Box to simultaneously compensate UPLINK & DOWNLINK by  
DOWNLINK measurements

1) André Bösel at [de.wikipedia](https://de.wikipedia.org), download 22.02.2016

# Motivation: Laser communication with GEO satellite

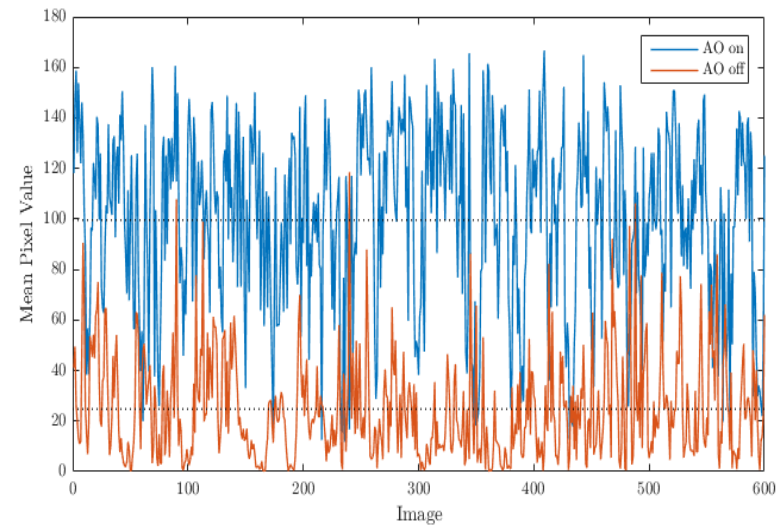
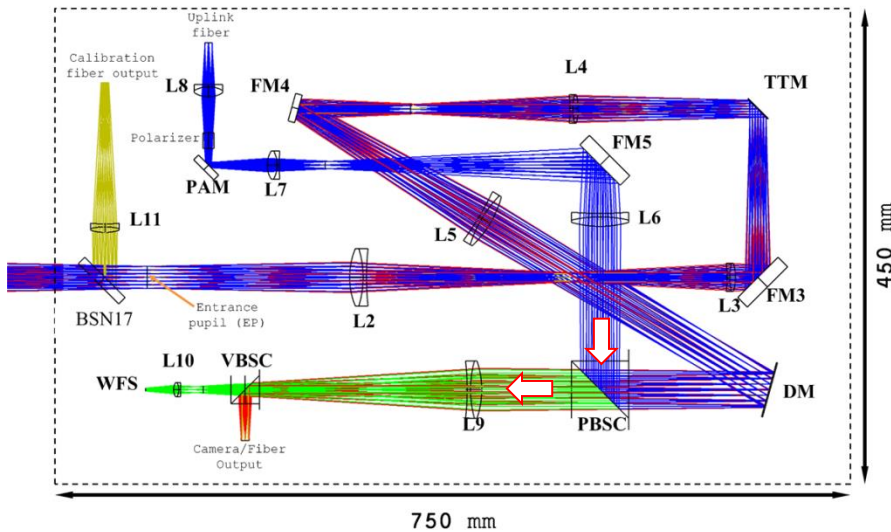
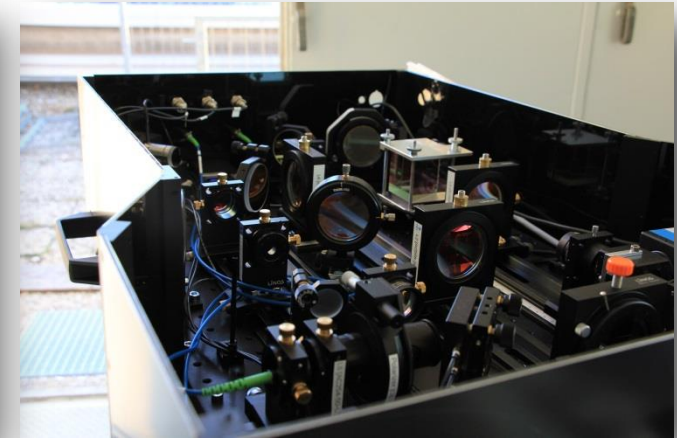


AO-Box to simultaneously compensate UPLINK & DOWNLINK by  
DOWNLINK measurements



# Current Activities: AO Box for pre- and post- compensation

- Portable AO Box coupled with any telescope
- Turbulence mitigation for both DL and UL
- Initial results: 6dB increase



# Outlook:

## Adaptive Optics for Quantum Key Distribution - Ground

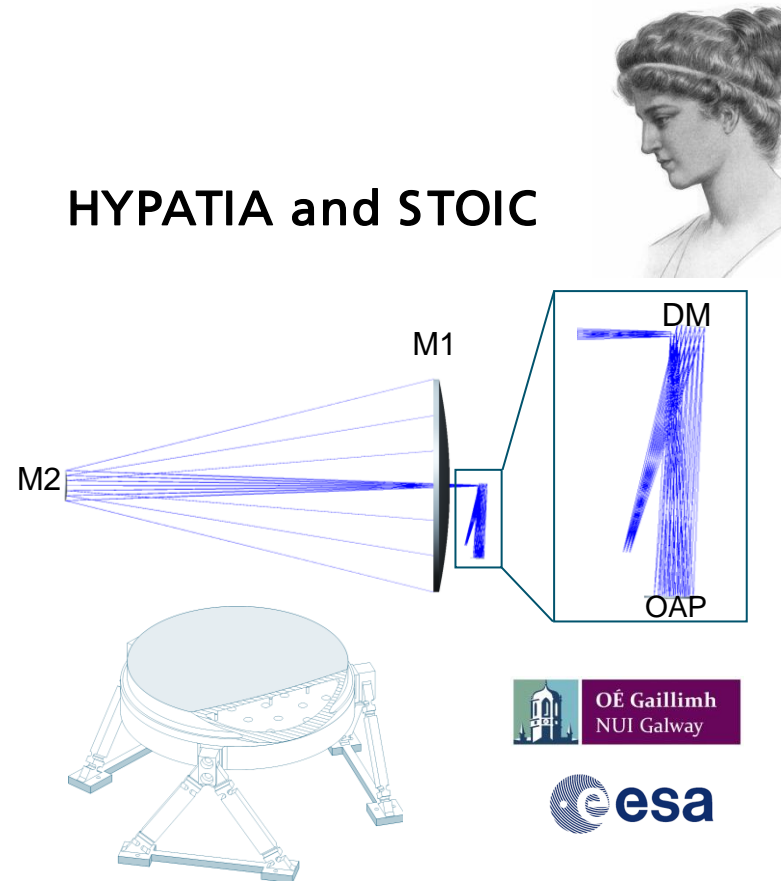
- Motivation: collect as much light as possible
- QKD
  - Fiber coupling for photon detection
  - Analysis of individual photons where the BER is critical
  - Highly sensitive to atmospheric turbulence
- Integration of AO system into QKD ground terminal



# Outlook:

## Active Optics for Quantum Key Distribution - Satellite

- Motivation: collect as much light as possible
- Larger telescope apertures – achieve high resolution with extremely light weight optics
- Active deformable mirrors – compensation of manufacturing induced aberrations and higher order aberrations
- Require very stable and precise optics – set and forget



Contract number: AO/1-7955/14/NL/

Thank you for your attention!

